inches long, behind which ants make their nests. *Conocephalus* bears its leaves in terminal clusters, and since seldom more than five leaves are in each cluster, the ants must keep moving their nests at short intervals. Species of *Hydnophytum* and *Myrmecodia* are frequently seen, with large swollen tuberous bases, perforated with numerous holes and inhabited by ants. Since these plants are epiphytes, one can easily understand that these swollen bases are organs for water storage rather than definite myrmecophilous adaptations.

*(To be continued)*

## A SIMPLE METHOD OF MAKING CARBON LEAF IMPRESSIONS

By E. D. Merrill

With the present development of photography it is usually a very simple matter to photograph any botanical specimen when a graphic representation of a borrowed type, or one examined in some distant herbarium, is desired for future reference. It sometimes happens, however, that it is not always practicable to make photographs, or to have them made, in which case recourse may be had to the simple, rapid, and effective method of making leaf impressions indicated below.

It is quite unnecessary to argue the value of graphic illustrations of plants or parts of plants, for the utility of botanical illustration is everywhere acknowledged. In a surprisingly high percentage of cases the graphic outline of a characteristic leaf of a type or typical specimen is of the very greatest value in supplementing the published description of a species, and in assisting the systematist in future identifications. In some families of plants, notably in the monocotyledons, leaf outlines will prove to be of little value in making ordinary determinations, and the same applies to certain families and genera of dicotyledonous plants. Generally, however, all broad leaved plants are adapted to the method of outlining described below, and carbon rubbings or impressions of such leaves are of the very greatest value in

complementing published descriptions, whether such descriptions be brief and imperfect, or whether they be very detailed.

The subject of making leaf impressions or prints is not new, nor does the method described here originate with me, yet I have never seen this particular method described in print. Its utility is so great, and the possibility of its application to other purposes, illustration, for instance, is so evident, that the publication of a short description of the method seems to be warranted. Perhaps the very simplicity of the method explains why it has not previously attracted attention among systematic botanists.

Fig. 1. *Ulmus campestris* L.

The method described by Berry* can be utilized only when leaves can be sacrificed, as his method involves the removal of a leaf from the specimen and the smearing of both surfaces with ink. Manifestly this method should never be used in making prints of the leaves of type specimens, or of other valuable botanical material.

* A method of making leaf prints. Torreya 2: 62–64, 1911.

In December, 1907, I was working at Kew rather laboriously and imperfectly penciling outlines of the leaves of certain types of Philippine plants preserved in the Kew Herbarium, and adding details of venation as well as I was able to do so with the time at my command and with my very slightly developed artistic ability. While thus engaged Mr. N. E. Brown called my attention to a method used by him in making carbon rubbing outlines of aroid leaves. This method he had developed in order to preserve for the Kew Herbarium graphic representations of certain species not represented in the collection by actual specimens. In essentials the method described below does not differ from that used by Mr. Brown, except that where he prepared his own paper by smoking it over a flame, I merely substituted for his home-made carbon paper ordinary typewriter carbon paper that can be secured in all parts of the world.

The leaf selected for outlining is not to be removed from the specimen, but over it, as it lies attached to the stem, and perhaps glued to the herbarium sheet, is placed a sheet of ordinary black carbon paper, medium hard finish, with the carbon surface upward. Over this is placed a piece of rather thin but firm, slightly rough finish, unglazed white paper of good quality. The white paper and the underlying carbon paper should then be held firmly in position over the selected leaf with the one hand, and rubbed with a steady firm pressure with the tips of the first two fingers of the other hand. Great care should be taken that the paper does not slip. The carbon paper will make an exact impression of the leaf, its shape, and even the minute details of its venation, on the lower surface of the white paper. As the rubbing progresses the result can be inspected from time to time, merely by raising the side or end of the white paper, until an impression sufficiently distinct has been secured. These carbon rubbings can be made very quickly, a few seconds sufficing for ordinary leaves, they are very permanent, and they can be made without danger of injuring ordinary botanical specimens. In very thin leaves, such as those of dried specimens of *Begonia*, dried aroid leaves, etc., while the venation is often very distinct to the eye, the veins and reticulations are not sufficiently raised

to make strong carbon rubbings. In such cases the lines can readily be strengthened by using a pencil. For purposes of illustration leaves may be outlined by this carbon paper method, the lines inked, and the drawing afterward cleaned up with a soft eraser, with the absolute certainty that the drawing will represent the true outline of the leaf and the details of its venation down to the ultimate reticulation.

FIG. 2. *Platanus orientalis* L.

In herbarium practice I have found these carbon rubbings or impressions to be of the very greatest utility. To illustrate their value I will merely cite a few representative cases. In January, 1908, I made a carbon impression of a single typical leaf of *Bauhinia warburgii* Perk., the type of which is preserved in the Berlin herbarium. This species did not appear in our Philippine collections until the year 1912 or 1913, yet when it did appear I was enabled at once to identify the specimen, merely by direct comparison with my carbon rubbing of a single leaf from the type, and a very brief examination of the printed description.

In the case of *Cynometra warburgii* Harms, a carbon rubbing of two or three leaves of the type enabled me at once to determine the identity of the species when it finally appeared in our Philippine collections, although the second collection of the species was sterile, that is, without flowers and without fruits. While at Berlin the Director of the Museum Království Českého at Prague kindly loaned me a number of types of Philippine plants collected by Haenke, among them four types of *Piper* described by Opiz. Of these types I made carbon impressions of the leaves. These carbon rubbings were later submitted to M. C. DeCandolle with the Philippine specimens of *Piper*, whereupon he was able definitely to place all of them, although in his monograph of the Piperaceae* all were placed under the heading "Species non satis notae." Two species described by Opiz, of which I did not see the types, *Piper haenkeanum* and *Piper rufinerve*, and hence secured no leaf impressions, still remain unrecognizable because of their imperfect original descriptions.†

Carbon rubbings or impressions of leaves not infrequently present details of the venation better than do some photographs, and have the distinct advantage of always showing the leaf the exact size of the original. It is believed that in many cases carbon leaf prints would be a valuable adjunct to actual photographs of types.

The leaf prints can be mounted on herbarium sheets, protected against undue rubbing or smudging by a protective flap of some thin smooth paper, such as onion skin paper, and are thus immediately available for purposes of direct comparison. The original description, and other data, can be copied on the sheet with the leaf impression. From a simple examination of a carbon rubbing of a typical leaf of a type, together with a study of the original description and the examination of additional material from the same general region from which the type came, species that have long been obscure, unknown, or entirely overlooked, can usually be recognized. This applies even in such

* Prodromus $16^1$: $235^{65}$–471. 1869.

† DeCandolle, C. A Revision of Philippine Piperaceae. Philip. Journ. Sci. 5: Bot. 405–463. 1910.

critical genera as *Eugenia*, *Ficus*, *Quercus*, *Piper*, *Begonia*, etc. With some graphic representation of the type, even if only of a single leaf, a far more accurate conception of the species can be secured than by a most critical study of the description alone.

Certain considerations are essential to success in making carbon leaf impressions. In the first place the paper selected should be of good quality, thin but firm, slightly rough in finish.

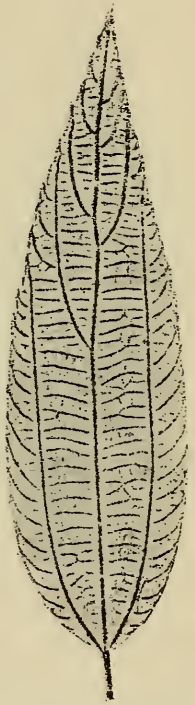

FIG. 3. *Leucosyke capitella* Wedd.

and not glazed. The carbon paper should be of medium hardness; if too hard it is difficult to make clear impressions, and if too soft the finished impression is apt to rub or smudge too easily. A clearer impression will usually result if the finger used in rubbing be first wrapped with a single thickness of a linen or cotton handkerchief, or with a small piece of cotton cloth, the slightly rough surface of the cloth on rubbing over the paper giving a sharper impression than will the naked finger. Like-

wise sharper outlines as to venation and reticulations will usually be secured if the lower surface of the leaf be selected in preference to the upper. In selecting leaves for outlining care must be taken not to injure the specimen, especially if it is a type. Wrinkled or very brittle leaves should never be selected, and care should be taken to avoid those that are so mounted that they might be broken if rubbed too hard.

About eight years' use of these carbon rubbings or impressions has thoroughly convinced me of their practical utility in herbarium work. Several European botanists to whom I explained the simple method of making the carbon rubbings were at once impressed with the utility and advantages of the method and have adopted it in their regular herbarium work. The advantages of the method are so great, the technique so simple, and the preperation of the impressions or rubbings so rapid, it is believed that rapidity, accuracy, and ease in certain lines of routine herbarium work will be greatly enhanced by the general utilization of this simple method. The illustrations accompanying this paper are reproductions of carbon rubbings or impressions, not at all retouched, prepared by the method described above.

WASHINGTON, D. C.,
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## REVIEWS

### Cowles and Coulter's Spring Flora*

The purpose of this flora, as stated by the authors, is "to provide, especially for young people in high schools, a ready means for the identification of the more common and widespread spring flowering plants." Descriptions are given of 380 plants which flower before July in the North Central and Eastern States and there is a single comprehensive key to the various species treated, based on such characteristics as are readily observable in spring. The work is illustrated by nearly 150 drawings.

As an introductory guide for the identification of the spring flowering plants in the area covered it is difficult to see how this little book can be improved upon. One notes with some surprise,

* Cowles, H. C., and Coulter, J. G. A Spring Flora for High Schools. Pp. 1–144. American Book Co. 1915.